DOT/FAA/AM-00/12

Office of Aviation Medicine
Washington, D.C. 20591

The Effects of Previous Computer Experience on Air Traffic-Selection and Training (AT-SAT) Test Performance

Michael C. Heil
Brandy O. Agnew
Civil Aeromedical Institute
Federal Aviation Administration
Oklahoma City, Oklahoma 73125

April 2000

Final Report

U.S. Department of Transportation
Federal Aviation Administration

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/AM-00/12		

4. Title and Subtitle	5. Report Date
The Effects of Previous Computer Experience on Air Traffic-Selection and Training (AT-SAT) Test Performance	April 2000
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Heil, M.C., and Agnew, B.O.	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
FAA Civil Aeromedical Institute P.O. Box 25082 Oklahoma City, OK 73125	11. Contract or Grant No.
12. Sponsoring Agency name and Address	13. Type of Report and Period Covered
Office of Aviation Medicine Federal Aviation Administration 800 Independence Ave., S.W. Washington, DC 20591	14. Sponsoring Agency Code

15. Supplemental Notes

16. Abstract

Many tests that have traditionally been administered in paper-and-pencil format are now administered on a computer workstation. One disadvantage of computer administered tests, however, is the inadvertent measurement of extraneous abilities related to prior experience with a computer keyboard or mouse. Surprisingly, there has been little written in the scientific literature about the use of computers in the selection process by organizations. The current study examines the relationship between computer experience and test performance using a computerized selection test. Specifically, some computerized tests, often referred to as "page-turner" tests, present items that have been adapted to the computer and require the examinee to use the keyboard to select a response to the questions, which are presented one at a time. Another type of test is that which takes the form of dynamic virtual scenarios, work samples, or simulations. These may resemble a video or computer game and often require extensive use of both a mouse and a keyboard. The two main objectives of this study are: to determine if examinees with more computer experience perform better than examinees with less computer experience, and to determine if the relationship between computer experience and computerized test performance remains consistent, regardless of the type of test being presented in the computerized format. A total of 96 people between the ages of 18 and 30 participated in the study. Computer experience was measured using the Computer Use and Experience Questionnaire. The personnel selection test used was the Air Traffic-Selection and Training (AT-SAT) test. The relationship between computer experience and performance on the computerized selection test was investigated using Pearson's product-moment correlations and hierarchical multiple regression. MANOVA and t-tests were also used to identify group differences on the dependent variables. Education was most predictive of AT-SAT performance, and people with more computer experience received higher composite AT-SAT scores. Future studies should explore the extent to which computer experience adds incremental validity over a selection test in predicting job performance, as well as investigate how training may change the relationship between computer experience and test performance so that the effect on personnel decision-making is minimized.

17. Key Words	18. Distribution Statement
Air Traffic Control Specialist, Personnel Selection, Computerized Tests, Computer Experience	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	14	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

The Effects of Previous Computer Experience on Air Traffic-Selection and Training (AT-SAT) Test Performance

Computers have been used more frequently in test administration in recent years. Many tests that have traditionally been administered in paper-and-pencil format are now administered on a computer workstation (Finegan & Allen, 1994; Lee, 1986; Mead & Drasgow, 1993). Computers provide a faster and easier method of assessing performance and cognitive ability. Additionally, computers provide a means to measure performance using dynamically changing stimuli or scenarios (Mead & Drasgow, 1993). One disadvantage of computer administered tests, however, is the inadvertent measurement of extraneous abilities related to prior experience with a computer keyboard or mouse, rather than measurement of relevant knowledge, skills, abilities, and other characteristics (KSAOs) needed for the job. This issue is particularly important in the realm of personnel selection, given the legal ramifications and potential adverse impact that may result from incorporating information into the selection process that is not job-related. The purpose of this paper is to explore the relationship between prior computer experience and performance on a computerized personnel selection test.

Although the use of computers in the selection process is becoming increasingly popular, there has been relatively little written in the scientific literature about their use by organizations. The effect of computer experience on computerized test performance has received more attention in the education literature, where researchers have studied two primary issues related to computerized testing: computer anxiety (Bradley & Russell, 1997; Dimock & Cormier, 1991; Legg & Buhr, 1992; Levine, & Donista-Schmidt, 1998; Powers & O'Neill, 1993) and the equivalence of paper-and-pencil and computerized tests (Finegan & Allen, 1994; Mead & Drasgow, 1993). Two findings have generally emerged: 1) people with more computer experience reported less computer anxiety, while people with higher levels of computer anxiety failed to perform as well on computerized tests, and 2) the differences in performance between paper-and-pencil and computerized tests were negligible.

The current study examines the relationship between computer experience and test performance using a computerized selection test. One of the main objectives of this study was to determine if examinees with more computer experience perform better than examinees with less computer experience. More specifically, does previous computer experience give examinees an advantage when taking a computerized test? The converse is of particular importance in the arena of personnel selection: Does a lack of computer experience put examinees at a disadvantage? In a study exploring the performance of undergraduate students on a computerized test of arithmetic reasoning, Lee (1986) found that prior computer experience improved performance. She observed that computerized testing might discriminate against those who have not worked with computers. This should be of great importance to hiring organizations since all racial groups do not have the same access to computers. According to a survey conducted by the U.S. Department of Commerce (1999), 46.6% of White households have a computer, as compared to only 23.2% of Black households and 25.5% of Hispanic households. Further analyses revealed that white households have more computers than other racial groups at all levels of income (U.S. Department of Commerce, 1999).

Another objective of the current study was to determine if the relationship between computer experience and computerized test performance remains consistent, regardless of the type of test being presented in the computerized format. For example some computerized tests, often referred to as "page-turner" tests, present items that have been adapted to the computer but could also be presented via another medium such as paper-and-pencil. In most cases, the examinee uses the keyboard to select a response to the questions, which are presented one at a time. Another type of test is that which takes the form of dynamic virtual scenarios, work samples, or simulations. The dynamic, scenario-based items, which may resemble a video or computer game, often require extensive use of both a mouse and a keyboard. An examinee with

no computer experience may be at a disadvantage when responding to items that require these computer skills. This proposal would be consistent with the findings of Young, Broach, & Farmer (1997), who observed that self-reported video game experience was related to performance on a computer-based air traffic scenario test.

The literature review and summary of relevant issues presented above led to the following hypothesis: A relationship exists between computer experience and performance on computerized tests; specifically, people with prior computer experience will earn higher scores on the computerized selection tests. Furthermore, the relationship between computer experience and test performance will be greater on tests that require the use of a mouse in addition to the keyboard, such as in the case of dynamic, scenario-based tests.

METHOD

Participants

In an effort to ensure that the participants in this study were representative of potential applicants, they were required to meet the basic age and educational qualifications for the air traffic controller job. A total of 96 participated in the study, 55 male and 41 female, between the ages of 18 and 30: Other demographic information is presented in Table 1. An outside personnel agency recruited participants, who were paid an hourly rate.

Measures

Computer Experience. Computer experience was measured using the Computer Use and Experience Questionnaire (CUE) developed by Potosky and Bobko (1997). This questionnaire consisted of twelve items (Appendix A) that are answered on a 5-point Likert Scale (1=Strongly Disagree, 2=Disagree, 3=Neither Agree nor Disagree, 4=Agree, 5=Strongly Agree). The purpose of administering the questionnaire was to determine the subject's knowledge of computers and to assess the extent to which he or she has used a computer. These items were summed to create a composite score. Potosky and Bobko reported a coefficient alpha of .92.

For the purpose of analyses, the composite computer experience score was used as the measure of computer experience for all analyses other than the Multiple Analysis of Variance (MANOVA). The

Table 1. Demographics

Variable	Number	Percent
Age		
18-20 years	20	20.8
21-23 years	26	27.1
24-26 years	23	23.9
27-30 years	27	28.1
Gender		
Male	55	57.3
Female	41	42.7
Race		
Minority	36	39.6
Non-Minority	55	60.4
Education		
High School	24	25.3
Trade School	8	8.4
Attend College	49	51.6
College Degree	10	10.5
Graduate School	4	4.2

Table 2. Computer Experience Items

I am computer literate.	
• Agree	60.4%
• Disagree	39.6%
I regularly use a PC for word processing.	
• Agree	57.3%
• Disagree	42.7%
I am good at using computers.	
• Agree	52.1%
• Disagree	47.9%

item "I regularly use a PC for word processing" was used individually in the MANOVA to improve understanding of the relationship between the use of a computer for these specific tasks and performance on computerized tests. The distribution of responses to three specific items, "I am computer literate," "I regularly use a PC for Word Processing," and "I am good at using computers," is shown in Table 2.

Personnel Selection Test. The personnel selection test used in the current study is the Air Traffic-Selection and Training (AT-SAT) test, a newly developed, computerized test of cognitive ability. This test will be used by the FAA to select individuals into the Air Traffic Control Specialist (ATCS) job. The AT-SAT battery is comprised of seven tests of cognitive ability and one non-cognitive measure. The non-cognitive measure was included in the AT-SAT composite score but was not used independently in the current study, as the focus of the study was on cognitive ability tests. In addition to the AT-SAT composite score based on total test performance, scores were also calculated for each cognitive test included in the battery. A description of each subtest follows.

The Applied Math test contains 30 multiple-choice questions. The first five items are practice questions followed by 25 scored items. An example of an Applied Math question is: *A plane has flown for 3 hours with a ground speed of 210 knots. How far did the plane travel?* Each of these questions requires the subject to make calculations based on time, speed, and distance to identify the correct answer from among four choices.

The Angles test measures the subject's ability to recognize the measurement of angles. This test contains 30 multiple-choice questions with four response options. There are two types of questions on the test. The first type presents a picture of an angle and requires the subject to estimate (in degrees) the correct size of the angle. The second type presents a measure in degrees (e.g. "35°") and asks the subject to choose the depicted angle that best represents that degree measurement.

The Letter Factory test (LF) simulates four factory assembly lines, each of which manufactures one of four letters of the alphabet (A, B, C, or D) in one of three colors. The test requires that subjects use a mouse to perform multiple and often concurrent tasks. Each test section begins with letters that appear at the top of the conveyor belts and move down toward the loading area. The object of the test is to "load" each of the colored letters into boxes that correspond to the letter's color (e.g., an orange letter must go into an orange box). Based on the letters on the conveyor belts, subjects immediately begin selecting and moving boxes to the loading area to provide just the right number and color of boxes to correctly place all letters. Other tasks performed during the simulated factory settings include: (1) ordering new boxes when supplies become low, and (2) calling Quality Control when defective letters appear (i.e., letters that are not As, Bs, Cs, or Ds). The LF test produces two scores: LF situational awareness and LF planning and thinking ahead.

The Air Traffic Scenarios Test (ATST) is a low-fidelity simulation of an air traffic control (ATC) radar screen that is updated every seven seconds. The goal is to maintain, as efficiently as possible, separation and control of a varying number of simulated aircraft (represented as data blocks) within the designated airspace. Aircraft in flight can pass through the airspace or land at one of two airports within the airspace. Each aircraft's data block indicates its present heading, speed, and altitude. There are eight different headings representing 45 degree increments, three different speeds (slow, moderate, fast), and four different altitude levels (1=lowest and 4=highest). Separation and control are achieved by communicating and coordinating with each aircraft by using the computer mouse to click on the data block representing each aircraft and providing instructions such as changes to the current heading, speed, or altitude. The ATST produces three scores: AT Efficiency, AT Safety, and AT Procedural Accuracy.

In the Scan test, subjects monitor a field on the screen that contains discrete objects (called data blocks), which are ½-inch tall and are moving in different directions. Data blocks appear in the field, travel in a straight line for a short period of time, and then disappear. During the test, the subject sees a blue field that fills the screen, with the exception of a two-inch white bar at the bottom. In this field, up to 12 green data blocks may be present. Each data block contains two lines of letters and numbers separated by a horizontal line. The upper line is the identifier and begins with a letter followed by a two-digit number. The lower line contains a three-digit number. Subjects are scored on the speed with which they notice and respond to the data blocks that have a number on the lower line outside a specified range.

Throughout the test, this range is displayed at the bottom of the screen (e.g., 360-710). To "respond" to a data block, the subject types the two-digit number from the upper line of the block (ignoring the letter that precedes it), and then presses "enter."

The Dial Reading test measures the subject's ability to quickly identify and accurately read certain dials on an instrument panel. Subjects are asked to choose from one of five response alternatives for each question about a given display. The test consists of 20 questions. Individuals pace themselves against the display of time remaining in the subtest. Subjects are advised to skip difficult items and return to them at the end of the test. Each panel consists of seven dials in two rows, a layout that remains constant throughout the test. Each of the seven dials contains unique flight information (e.g., air speed, fuel, temperature).

The Analogies test measures the subject's ability to apply the correct rules to solve a given problem as well as their efficiency in using the available information to solve that problem. Analogies are based on words, pictures, or figures and appear in three "windows" on the same screen for a given item. Subjects use a mouse to move freely between the three windows, view the different parts of the analogy, and select their answer. However, they can view only one window at a time. Window A presents the first part of the analogy, which requires subjects to infer the underlying rule. Window B contains the second part of the analogy, which requires subjects to apply the inferred rule. Finally, Window C provides subjects the opportunity to confirm their choice by selecting their answer from the available response options. The test has 57 items: 30 word analogies and 27 visual (i.e., either pictorial or figural) analogies.

As stated above, one of the objectives of the current study was to determine if performance on certain types of tests was affected more by computer experience than performance on other types. The ATST and LF tests are dynamic scenario-based tests that require the use of the mouse. The scan test is also a dynamic test but requires use of the keyboard number pad, rather than a mouse. The analogies test is a static test that requires use of the mouse to view different parts of the screen and to select the correct response. The applied math, angles, and dial reading tests are static "page-turner" tests that require only the use of the keyboard to select the correct response for multiple choice questions.

Procedure

All subjects participated in a pre-screening session prior to administration of the selection test. During this time, they were informed of the purpose of the study, were given voluntary consent forms, and completed biographical information questionnaires. Ten participants could be tested simultaneously based on the availability of computer workstations. Participants were randomly assigned to groups of ten. All computer workstations were separated by partitions. Participants were given the same instructions before beginning the test battery. The computer experience questionnaire was administered at the beginning of the session as part of the AT-SAT test. Participants received ten-minute breaks between certain sections of the test, as well as a 45-minute break for lunch. The average testing time was approximately six hours.

RESULTS

The relationship between computer experience and performance on the computerized selection test was investigated using Pearson's product-moment correlations and hierarchical multiple regression. MANOVA and t-tests were used to identify group differences on the dependent variables. The results of these analyses are presented below.

Computer experience/ test score relationship

The AT-SAT subtest correlation matrix, presented in Table 3, revealed statistically significant correlations between most of the tests within the AT-SAT battery. Pearson's product-moment correlations were used to investigate the linear relationship between computer experience and AT-SAT scores. As shown in Table 4, there was a moderate correlation between computer experience and AT-SAT composite score (r=.38, p<.01). An examination of relationships between computer experience and individual AT-SAT subtest scores revealed that computer experience was not significantly correlated with the dial reading, scan, and AT-Scenarios procedural accuracy scores. Computer experience was most highly correlated with the letter factory (LF) situational awareness (r=.45, p<.01), applied math (r=.37, p<.01), and AT efficiency (r=.365, p<.01) measures. As demonstrated by these correlations, and contrary to the hypothesis,

Table 3. Correlation of AT-SAT Sub-tests

	1	2	3	4	5	6	7	8	9	10	11	12
1. Dials	1.00											
2. Angles	.603*	1.00										
3. Amath	.559*	.702*	1.00									
4. LF SA	.430*	.430*	.599*	1.00								
5. LF TP	.428*	.527*	.560*	.603*	1.00							
6. Analogies	.617*	.753*	.705*	.576*	.511*	1.00						
7. Scan	.377*	.410*	.496*	.422*	.550*	.465*	1.00					
8. AT Eff.	.514*	.479*	.625*	.691*	.549*	.522*	.422*	1.00				
9. AT Safe	.146	.107	.198	.415*	.169	.143	.005	.368*	1.00			
10. AT PA	.413*	.367*	.379*	.284*	.340*	.353*	.375*	.440*	-.119	1.00		
11. AT Total	.490*	.434*	.562*	.681*	.495*	.471*	.353*	.868*	.686*	.518*	1.00	
12. AT-SAT Composite	.727*	.846*	.913*	.691*	.699*	.835*	.633*	.715*	.246	.477*	.671*	1.00

* Correlation is significant at the 0.01 level (2-tailed)

Table 4. Correlation of AT-SAT Subtests With Computer Experience

Test	Computer Experience Score
Dials	.196
Angles	.266**
Amath	.372**
LF SA	.447**
LF TP	.283**
Analogies	.339**
Scan	.199
AT Eff.	.365**
AT Safe	.207*
AT PA	.054
AT Total	.318**
AT-SAT Composite	.380**

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Table 5. Hierarchical Multiple Regression of Age, Education, and Computer Experience on Composite AT-SAT Score

	ATSAT Comp.	Age	Educ.	B	β	ΔR^2	R^2=.258*
Age	-.045			-.196	-.048	.002	**Adjusted R^2 = .233**
Education	.456**	.129		4.642	.375	.217**	
Computer Experience	.380**	.205*	.389**	.317	.224	.039*	R=.508

*$p<.05$
**$p<.01$

no clear pattern of relationship emerged between computer experience and test performance based on whether the test was static or dynamic.

Hierarchical regression was used to determine the amount of variance in test performance that was explained by computer experience after age and education were taken into account. The AT-SAT composite test score and each AT-SAT subtest score were used as dependent variables in a series of separate regression analyses. As shown in Table 5, age did not contribute significantly to the prediction of the AT-SAT composite score. When entered into the regression equation, education contributed significantly to the prediction of AT-SAT score (ΔR^2=.217, $p<.01$). Computer experience, which was then entered into the equation after education, resulted in a significant R^2 change in predicting the AT-SAT score (ΔR^2=.039, $p<.05$). Based on the adjusted R^2, the overall model of age, education, and computer experience accounted for 23.3% of the variance in the composite AT-SAT score.

A summary of the regression analyses for each AT-SAT subtest is provided in Table 6. For each analysis, the independent variables were entered in the following order: age, education, and computer experience. A separate analysis was performed for each AT-SAT subtest score. Age did not contribute significantly to the prediction of any of the subtest scores. Education added significantly to the prediction of the following scores: Analogies (ΔR^2=.242, $p<.01$), Applied Math (ΔR^2=.218, $p<.01$), Angles (ΔR^2=.179, $p<.01$), LF Situational Awareness (ΔR^2=.148, $p<.01$), Dial Reading (ΔR^2=.094, $p<.01$), AT Total (ΔR^2=.091, $p<.01$), AT Efficiency (ΔR^2=.088, $p<.01$), AT Safety (ΔR^2=.083, $p<.01$), and LF Planning and Thinking Ahead (ΔR^2=.055, $p<.01$). Once age and education were entered into the regression equation, computer experience added significantly only to the prediction of LF Situational Awareness (ΔR^2=.091, $p<.01$), AT Efficiency (ΔR^2=.064, $p<.05$), LF Planning and Thinking Ahead (ΔR^2=.048, $p<.01$), and AT Total (ΔR^2=.041, $p<.05$). The results of the regression analysis support the hypothesized relationship between computer experience and performance on dynamic tests requiring use of a mouse. The regression weights and adjusted R^2 for each separate analysis are listed in Table 6.

Group comparisons

Differences in mean computer experience scores based on gender, race, and education were investigated using t-tests. The results, summarized in Table 7, revealed no significant gender or racial differences in mean computer experience score. However, participants who either attended or graduated from college had a significantly higher computer experience score than those with a high school or trade school education, t=-3.28 (92), $p<.05$.

A 2X2 between subjects MANOVA was performed on the ten AT-SAT subtests. Education and self-reported word-processing experience served as the independent variables. Order of entry of the independent variables was education, then word processing experience. Using Wilks' criterion, there was a significant main effect of both education, $F(10, 82)=2.75$, $p<.01$, and word processing experience, $F(10, 82)=2.14$, $p<.05$. The interaction was not significant. The results reflected a moderate association between both education (η^2=.25) and word processing experience (η^2=.21) and the combined dependent variables (DVs). Differences in AT-SAT test scores associated with age and education are presented in Appendix B.

Table 6. Regression of Age, Education, and Computer Experience on AT-SAT Sub-tests

Dependent Variable	Independent Variables	β	ΔR^2	Adjusted R^2
Dials	Age	-.096	.005	
	Education	.280	.094**	.073
	Computer Experience	.068	.004	
Angles	Age	-.070	.002	
	Education	.382	.179**	.162
	Computer Experience	.103	.008	
Amath	Age	.019	.000	
	Education	.374	.218**	.236
	Computer Experience	.231	.042	
LF SA	Age	-.053	.008	
	Education	.244	.148**	.223
	Computer Experience	.341	.091**	
LF TP	Age	.076	.002	
	Education	.131	.055*	.074
	Computer Experience	.247	.048*	
Analogies	Age	-.091	.004	
	Education	.432	.242**	.240
	Computer Experience	.152	.018	
Scan	Age	-.045	.006	
	Education	.028	.011	.010
	Computer Experience	.179	.025	
AT Eff.	Age	-.050	.007	
	Education	.178	.088**	.131
	Computer Experience	.285	.064*	
AT Safe	Age	-.153	.018	
	Education	.259	.083**	.076
	Computer Experience	.075	.004	
AT PA	Age	.184	.023	
	Education	-.067	.000	.002
	Computer Experience	.117	.011	
AT Total	Age	-.042	.004	
	Education	.208	.091**	.107
	Computer Experience	.228	.041*	

*p<.05
**p<.01

Table 7. Group Means and Results of t-Test of Computer Experience

Group	Computer Experience Score	
	Mean	(SD)
Gender		
• Male	39.75	(9.55)
• Female	37.20	(9.77)
Race		
• Minority	38.03	(8.15)
• Non-Minority	39.00	(10.88)
Education		
• High School	34.19	(7.13)
• College	40.83	(10.07)*

*p<.05

A stepdown analysis was performed on the prioritized DVs to investigate the effect of each main effect on the individual DVs. The DVs were prioritized according to their incremental validity in predicting job performance (Ramos, 1999). In stepdown analysis, each DV was analyzed with higher priority DVs treated as covariates and tested as a univariate ANOVA (Tabachnick & Fidell, 1996). Results of the stepdown analysis are presented in Table 8. Applied math provided a unique contribution to predicting differences between those with high school/trade school vs. college education, stepdown $\underline{F}(1, 91)=12.75$, $\underline{p}<.01$. Participants who attended college scored higher on the applied math test ($\underline{M}=12.35$) than did those with a high school or trade school education ($\underline{M}=8.77$). After the pattern of differences measured by applied math was entered, a difference was also found on the analogies test, stepdown $\underline{F}(1, 90)=4.70$, $\underline{p}<.05$. The participants who attended college scored higher on the analogies test ($\underline{M}=4.14$) than did those participants with a high school or trade school education ($\underline{M}=3.08$). Although a univariate comparison revealed that those with more education scored higher on the angles test, univariate $\underline{F}(1, 91)=9.10$, $\underline{p}<.01$, LF situational awareness, univariate $\underline{F}(1, 91)=4.58$, $\underline{p}<.05$, and the dial reading test, univariate $\underline{F}(1, 91)=4.58$, $\underline{p}<.05$, these differences were already represented in the stepdown analysis by higher-priority DVs.

As shown in Table 8, applied math made a unique contribution to predicting differences between those with and those without word processing experience, stepdown $\underline{F}(1, 91)=4.44$, $\underline{p}<.05$. Participants with experience using a computer for word processing scored higher on the applied math test ($\underline{M}=11.62$) than did those with no word processing experience ($\underline{M}=9.49$). With differences due to the applied math score already entered, the analogies test score contributed uniquely, stepdown $\underline{F}(1, 90)=8.14$, $\underline{p}<.01$. Participants with experience using a computer for word processing scored higher on the analogies test ($\underline{M}=4.09$) than did those with no word processing experience ($\underline{M}=3.12$). Although a univariate comparison revealed that participants with word processing experience scored higher on LF situational awareness, univariate $\underline{F}(1, 91)=11.01$, $\underline{p}<.01$, LF thinking and planning ahead, univariate $\underline{F}(1, 91)=6.76$, $\underline{p}<.05$, and AT efficiency, univariate $\underline{F}(1, 91)=7.49$, $\underline{p}<.01$, these differences were already represented in the stepdown analysis by applied math and analogies scores.

DISCUSSION

The results of the analyses described above provide evidence of a relationship between prior computer experience and performance on a computerized personnel selection test. In general, these results are consistent with those reported by Keenan (1999) during the AT-SAT validation study. The results of the Pearson product-moment correlations reported in the current study provide clear evidence of a positive relationship between computer experience and the AT-SAT composite score. Examination of the correlations between computer experience and the individual AT-SAT subtest scores provides insight into which of the tests are more affected.

Only three of the subtest scores (dial reading, scan, and AT procedural accuracy) were not correlated with computer experience. The lack of a relationship between dial reading score and computer experience is not surprising given that the dial reading test is a static "page-turner" multiple choice test. The examinee need only use the keyboard to select a particular response item. Since the scan and AT procedural accuracy scores are based on dynamic tests, the lack of a relationship between performance and computer experience is more surprising. However, closer inspection of the manner in which these scores are

Table 8. MANOVA of Education, Word Processing Experience, and Their Interaction

IV	DV	Univariate F	Df	Step-down F	Df
Education	Amath	12.57**	1/91	12.57**	1/91
	Analogies	15.70**	1/91	4.70*	1/90
	Angles	9.10**	1/91	.03	1/89
	LF SA	4.58*	1/91	.01	1/88
	LF TP	1.39	1/91	.98	1/87
	AT Safe	2.73	1/91	1.88	1/86
	AT Eff.	2.88	1/91	.40	1/85
	AT PA	.09	1/91	3.30	1/84
	Dials	4.58*	1/91	.00	1/83
	Scan	.05	1/91	2.71	1/82
Word Processing Experience	Amath	4.44*	1/91	4.44*	1/91
	Analogies	13.08**	1/91	8.14**	1/90
	Angles	3.78	1/91	.57	1/89
	LF SA	11.01**	1/91	3.52	1/88
	LF TP	6.76*	1/91	.45	1/87
	AT Safe	.92	1/91	.06	1/86
	AT Eff.	7.49**	1/91	.31	1/85
	AT PA	.26	1/91	2.08	1/84
	Dials	1.02	1/91	1.28	1/83
	Scan	2.89	1/91	.22	1/82
Education and Word Processing	Amath	7.00*	1/91	7.00*	1/91
	Analogies	3.33	1/91	.11	1/90
	Angles	.98	1/91	1.30	1/89
	LF SA	4.27*	1/91	.51	1/88
	LF TP	1.28	1/91	.11	1/87
	AT Safe	.65	1/91	.08	1/86
	AT Eff.	2.20	1/91	.11	1/85
	AT PA	.03	1/91	.91	1/84
	Dials	2.29	1/91	.29	1/83
	Scan	.04	1/91	3.38	1/82

*p<.05
**p<.01

derived provides some insight into this issue. The scan test requires the use of the keyboard for input of responses; the mouse is not used for this test. The AT procedural accuracy score is based on whether or not the examinee follows the correct procedures when directing the traffic in each scenario. For example, all planes must land at the airport, at the slowest speed and the lowest altitude. These rules remain the same regardless of the scenario. Quick and efficient mouse movement is not required for an examinee to score well on AT procedural accuracy.

Contrary to what was hypothesized, performance on the applied math and angles tests (which are static multiple choice tests) was correlated with computer experience. Further investigation revealed that this relationship might be due to the educational level of the examinee. The results of t-tests indicate that people with more education also had more computer experience. Hierarchical multiple regression revealed that computer experience did not add anything beyond education in predicting applied math or angles scores. Consequently, it was concluded that the significant correlation between computer experience and performance on these static tests was due to examinee education level.

Computer experience added significantly to the prediction of the dynamic, scenario-based tests that require the use of a mouse. After controlling for education, computer experience added to the prediction of LF situational awareness score, LF planning and thinking ahead score, and AT efficiency score. These results demonstrate that, after controlling for education, computer experience was related only to performance on dynamic scenario-based tests that require use of a mouse. The LF and ATST items require fast and efficient mouse manipulation. The relationship between computer experience and performance on these subtests was enough to influence the relationship between computer experience and performance on the overall AT-SAT composite score. The hierarchical multiple regression with AT-SAT composite as the DV revealed that computer experience produced a significant change in R^2 beyond education. Consequently, people with more computer experience received higher composite AT-SAT scores. Whether or not this relationship is due to overall experience with a computer or to experience with a mouse in particular is not known; the computer experience questionnaire did not contain a question specific to the use of a mouse. Such a question should be included in the future as it has implications for training interventions.

The results of the MANOVA stepdown analysis suggest that the pattern of differences on AT-SAT subtests between people with high school/ trade school education and college education were best measured by scores on applied math and analogies. The same is true of the differences between people with computer word processing experience vs. those without computer word processing experience. Consequently, the influence of the tests that provide an advantage to those with computer experience (LF, ATST) is minimal when the subtest scores are combined in a linear fashion based on their incremental validity in predicting job performance.

In summary, the results revealed that people with a higher level of education also had more computer experience. Once education level was controlled for, computer experience was correlated with performance on dynamic tests that required the use of a mouse. This relationship was sufficient to influence the selection test composite score, as demonstrated by the finding that computer experience added to prediction of the AT-SAT composite score even after controlling for education. The influence of these dynamic tests on the composite score might be a function of the weighting of these tests in the composite's calculation. Education was found to be most predictive of performance on AT-SAT. Currently, any adverse impact associated with the AT-SAT battery is unknown since the test is not yet operational. However, people with less computer experience may be at a disadvantage when taking a computerized test that requires the use of a mouse to complete a dynamic test. Since people of all races do not have equal access to computers (U.S. Department of Commerce, 1999), this disadvantage may contribute to adverse impact. The potential for disadvantage will depend on the number of such tests included in a selection battery, as well as their weight in calculating the composite score.

The relationship between computer experience and performance on a computerized selection test has important implications for personnel decision making. If dynamic scenario-based tests requiring the use of a mouse are heavily weighted in the calculation of a selection test score, the ranking of examinees among qualified applicants may be affected by whether or

not they had previously used a computer. Future studies should explore this issue as well as the extent to which computer experience adds incremental validity over a selection test in predicting job performance. Items pertaining to mouse and video game experience should also be added to the computer experience questionnaire, as these may help isolate the specific types of training that are most likely to be effective in reducing disparity between those with and without prior computer experience. This can assist in the development of a computer training intervention. It may be that such training need only focus on mouse usage, rather than on such things as operating systems and databases. Future research should also investigate the extent to which such training may change the relationship between computer experience and test performance so that the impact on personnel decision-making is minimized.

REFERENCES

Bradley, G., & Russel, G. (1997). Computer experience, school support, and computer anxieties. *Educational Psychology, 17,* 267-84.

Dimock, P.H., & Cormier, P. (1991). The effects of format differences and computer experience on performance and anxiety on a computer administered test. *Measurement and Evaluation in Counseling and Development, 24,* 19-126.

Finegan, J.E., & Allen, N.J. (1994). Computerized and written questionnaires: Are they equivalent? *Computers in Human Behavior, 10,* 483-96.

Keenan, P.A. (1999). Biographical and computer experience information: Demographics for the validation study. In Ramos, R., Heil, M.C., & Manning, C.A. (Eds.). *Documentation of Validity for the AT-SAT Computerized Test Battery.* (DOT/FAA/OAM Technical Report). Manuscript under review.

Lee, J.A. (1986). The effects of past computer experience on computerized aptitude test performance. *Educational and Psychological Measurement, 46,* 727-33.

Legg, S.M., & Buhr, D.C. (1992). Computerized adaptive testing with different groups. *Educational Research: Issues and Practice, 11,* 23-27.

Levine, T., & Donitsa-Schmidt, S. (1998). Computer use, confidence, attitudes, and knowledge: A causal analysis. *Computers in Human Behavior, 14,* 125-46.

Powers, D.E., & O'Neil, K. (1993). Inexperienced and anxious computer users: Coping with a computer administered test of academic skills. *Educational Assessment, 2,* 153-73.

Potosky, D., & Bobko, P. (1997). *Assessing computer experience: The computer understanding and experience scale (CUE).* Poster presented at the Society for Industrial and Organizational Psychology (SIOP), April 12, St. Louis, MO.

Ramos, R. (1999). *AT-SAT: Overview of an ambitious project.* Presented at The Society for Industrial and Organizational Psychology's 1999 Annual Conference, Atlanta, GA.

Tabachnick, B.G., & Fidell, L.S. (1996). *Using Multivariate Statistics* (3rd Ed.). New York; Harper Collins College Publishers.

U.S. Department of Commerce. (1999). *Falling through the net: Defining the digital divide.* Washington, D.C.: National Telecommunications and Information Administration (NTIS No. PB99-1444 87/INZ).

Young, W.C., Broach, D., & Farmer, W.L. (1997). *The effects of video game experience on computer-based Air Traffic Controller Specialist, Air Traffic Scenario test scores.* (DOT/FAA/AM-97/4). Washington, DC: Federal Aviation Administration Office of Aviation Medicine. Available from: National Technical Information Service, Springfield, VA 22161; order # ADA322774.

APPENDIX A

Computer Use and Experience Questionnaire

1. I frequently read computer magazines or other sources of information that describe new computer technology.
2. I know how to recover deleted or "lost data" on a computer or PC.
3. I know what LAN is.
4. I know what an operating system is.
5. I know how to write computer programs.
6. I know how to install software on a personal computer.
7. I know what e-mail is.
8. I know what a database is.
9. I am computer literate.
10. I regularly use a PC for word processing.
11. I often use a mainframe computer system.
12. I am good at using computers.

APPENDIX B

Mean AT-SAT Scores by Age and Education

AT-SAT Score	Age 18-21	Age 22-26	Age 27-30	F	Education H.S. or Trade	Education College	F
Amath	12.15 (5.03)	12.09 (5.31)	10.87 (5.45)	.54	8.82 (4.61)	13.14 (4.93)	17.0 *
Analogies	4.07 (1.26)	4.01 (1.51)	3.68 (1.56)	.59	3.04 (1.28)	4.38 (1.33)	22.2 *
Angles	11.65 (3.33)	11.20 (3.51)	10.83 (3.38)	.40	9.53 (3.70)	12.05 (2.92)	13.2 *
LF SA	1.87 (.81)	1.72 (.76)	1.52 (.71)	1.5	1.39 (.61)	1.87 (.79)	8.8*
LF TP	3.71 (1.15)	3.75 (1.11)	3.65 (1.01)	.06	3.41 (1.04)	3.86 (.18)	3.7*
AT Safe	2.89 (.89)	2.96 (.80)	2.58 (.70)	1.9	2.60 (.92)	2.95 (.73)	4.1*
AT Eff.	2.70 (.75)	2.72 (.88)	2.39 (.55)	1.8	2.35 (.68)	2.75 (.78)	6.0*
AT PA	1.85 (.59)	1.87 (.51)	2.05 (.49)	1.3	1.93 (.60)	1.91 (.50)	.03
Dials	9.92 (1.36)	9.91 (1.69)	9.48 (2.57)	.51	9.10 (2.08)	10.13 (1.71)	6.6*
Scan	8.10 (1.69)	8.45 (1.99)	8.31 (1.79)	1.1	8.40 (1.80)	8.67 (1.88)	.45

*p<.05
Standard Deviation in ( ).